Investigation On Different Compositions To Develop A Composite Materials Using Stir Casting Process And To Achieve The Better Hardness

Mr. ANGADI VENKATESH received the B.Tech degree in mechanical engineering from Aditya Engineering College, JNTU, Kakinada, Andhra Pradesh, India, in 2017 year and pursuing M.Tech in ADVANCED MANUFACTURING SYSTEMS from Pydah College of engineering, JNTU, Kakinada, Andhra Pradesh, India

Mr. MD.I. Rehman, **M.Tech. Asst. Prof. Department of Mechanical engineering** from Pydah College of engineering, Kakinada, Andra Pradesh, India

ABSTRACT

The present research was conducted to investigate the effect of elemental metal such as TiO_2 in aluminium matrix on mechanical properties of stir casting of aluminium composite materials reinforced using simple foundry melting alloying and casting route.

The age hardening treatments were also applied to study the aging response of the aluminium matrix on strength, ductility and hardness. In this project we are going to take 3 different compositions and one pure al alloy for the testing purpose, here the 3 different compositions are developed using stir casting process. And the testing is done to see the grain size of the particles for different compositions and then find the tensile and load results for the better matrix reinforced material.

Later after the casting process we ate going to investigate the effects of the various Wire cut EDM process parameters on the surface quality, maximum material removal rates & micro structure and obtain the optimal sets of process parameters so that the quality and MRR of machined parts can be optimized.

Experiments are conducted on the composite material of 3 different compositions i.e.

Al + tio_2 (5%)

Al + tio_2 (10%)

Al + tio_2 (20%)

Pieces by varying parameters, The process parameters varied and their respective values are Pulse Time on - 105µsec, 115 µsec, 125µsec & Pulse Time off – 32 µsec, 42 µsec, 52 µsec, Discharge Current – 10Amp, 11Amp, 12Amp. Other parameters are kept constant such as Wire Feed – 2mm/s, Wire dia - 0.25mm; Coolant is Distilled water, Wire Tension – 7Kgf. The optimization is done by using Taguchi technique, considering L9 orthogonal array. Optimization is done in Minitab software.

INTRODUCTION

Casting

Casting is a manufacturing process in which a liquid material is usually poured into a mold, which contains a hollow cavity of the desired shape, and then allowed to solidify. The solidified part is also known as a *casting*, which is ejected or broken out of the mold to complete the process. Casting materials are usually metals or various time setting materials that cure after mixing two or more components together; examples are epoxy, concrete, plaster and clay. Casting is most often used for making complex shapes that would be otherwise difficult or uneconomical to make by other methods. Heavy equipment like machine tool beds, ship's

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propeller etc. can be cast easily in the required size rather than fabricating them by joining several small pieces.

Casting is the process of producing metal/ alloy component parts of desired shapes by pouring the molten metal / alloy into a prepared mould (of that shape) and then allowing the metal/alloy to cool and solidify. The solidified piece of metal/alloy is known as casting. Casting is the basic process in industry, so we never skip it from industry. To enhance the casting process, we must need to improve the quality of sand improves this quality. A core is essentially a body of materials which forms components of the mould. It possesses sufficient strength to be handled as an independent unit. Core is an obstruction which when positioned in the mould, naturally does not permit the molten metal to fill up the space occupied by the core. In this way a core produces hollow casting. Cores are required to create the recesses, undercuts and interior cavities that are often apart of castings. Cores are employed as inserts in mould to form design features that are otherwise extremely difficult to produce by simple moulding. The dry silica sand is used as a basic refractory material for pre-preparing core .This sand withstands for high temperature of metal poured in the mould.

Fig – stir casting process

OBJECTIVE OF THE PRESENT WORK

The objective of the present work is to investigate the effects of the various Wire cut EDM process parameters on the surface quality, maximum material removal rates & micro structure and obtain the optimal sets of process parameters so that the quality and MRR of machined parts can be optimized.

Experiments are conducted on the composite material of 3 different compositions i.e.

Al + tio_2 (5%)
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Al + tio_2 (20%)

Pieces by varying parameters, The process parameters varied and their respective values are Pulse Time on - 105µsec, 115 µsec, 125µsec & Pulse Time off – 32 µsec, 42 µsec, 52 µsec, Discharge Current – 10Amp, 11Amp, 12Amp. Other parameters are kept constant such as Wire Feed – 2mm/s, Wire dia - 0.25mm; Coolant is Distilled water, Wire Tension – 7Kgf. The optimization is done by using Taguchi technique, considering L9 orthogonal array. Optimization is done in Minitab software.

Taguchi L9 Orthogonal Array

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The L9 orthogonal array for input parameters Pulse on time, pulse off time, servo voltage and wire feed is shown in table below:

JOB NO.	PULSE TIME ON (T_{ON}) (µsec)	PULSE TIME OFF (T_{OFF}) (µsec)	DISCHARGE CURRENT (Amp)	Al + TiO_2 (%)
1	105	32	10	5
2	105	42	11	10
3	105	52	12	20
4	115	32	11	20
5	115	42	12	5
6	115	52	10	10
7	125	32	12	10
8	125	42	10	20
9	125	52	11	5

Table – Process Parameters taken for machining

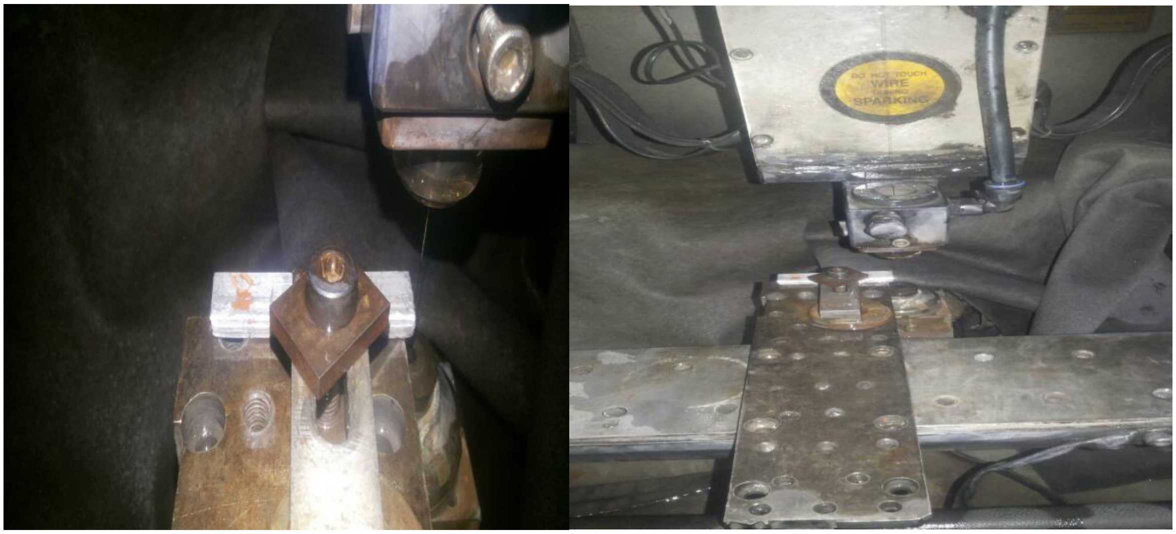
STIR CASTING PHOTOS

3 different compositions of work piece

EXPERIMENTATION PHOTOS

Wire Cut EDM Machine

Fig – Copper wire



Piece before Machining

Final machined pieces

MRR

In this project, Taguchi method is used to optimize the process parameters Pulse Time On, Pulse Time Off, Discharge Current and Wire Feed for higher material removal rates. The optimization is done in Minitab 17 software.

The MRR values calculated from the experimental data is as shown in below table.

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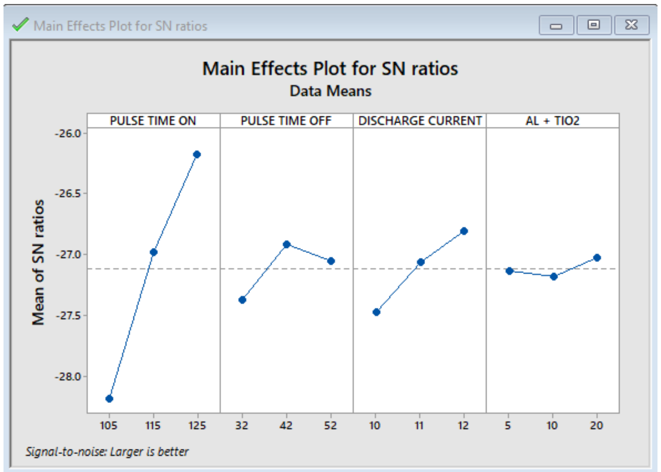

Fig - Effect of machining parameters on MRR for S/N ratio for Larger is better

SURFACE ROUGHNESS

Taguchi method is used to optimize the process parameters Pulse Time On, Pulse Time Off, Discharge Current and Wire Feed for lesser Surface Roughness values.

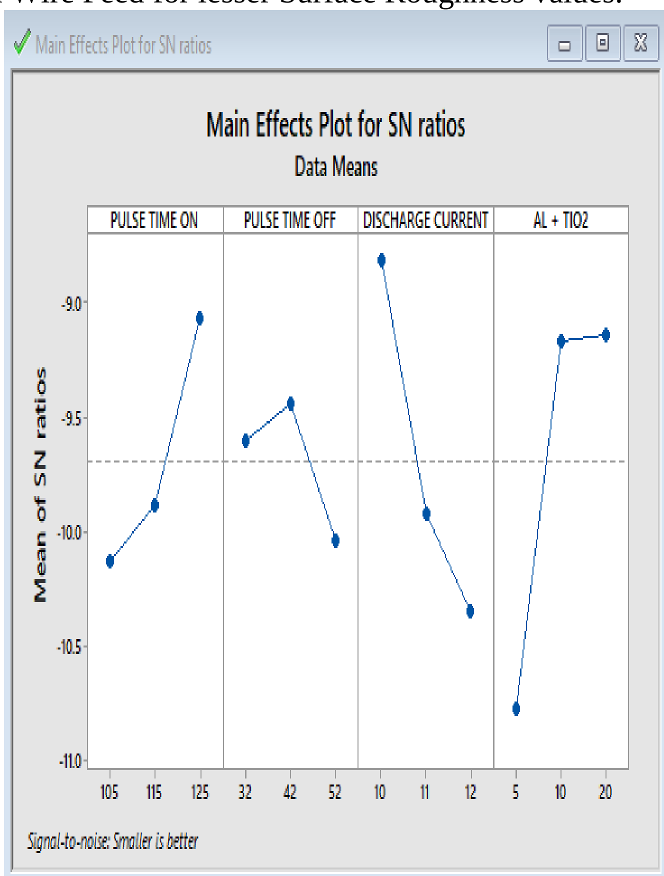

Fig - Effect of machining parameters on Surface Roughness for S/N ratio for Smaller is better

Tensile test reports


Shot on OnePlus
By MST


Shot on OnePlus

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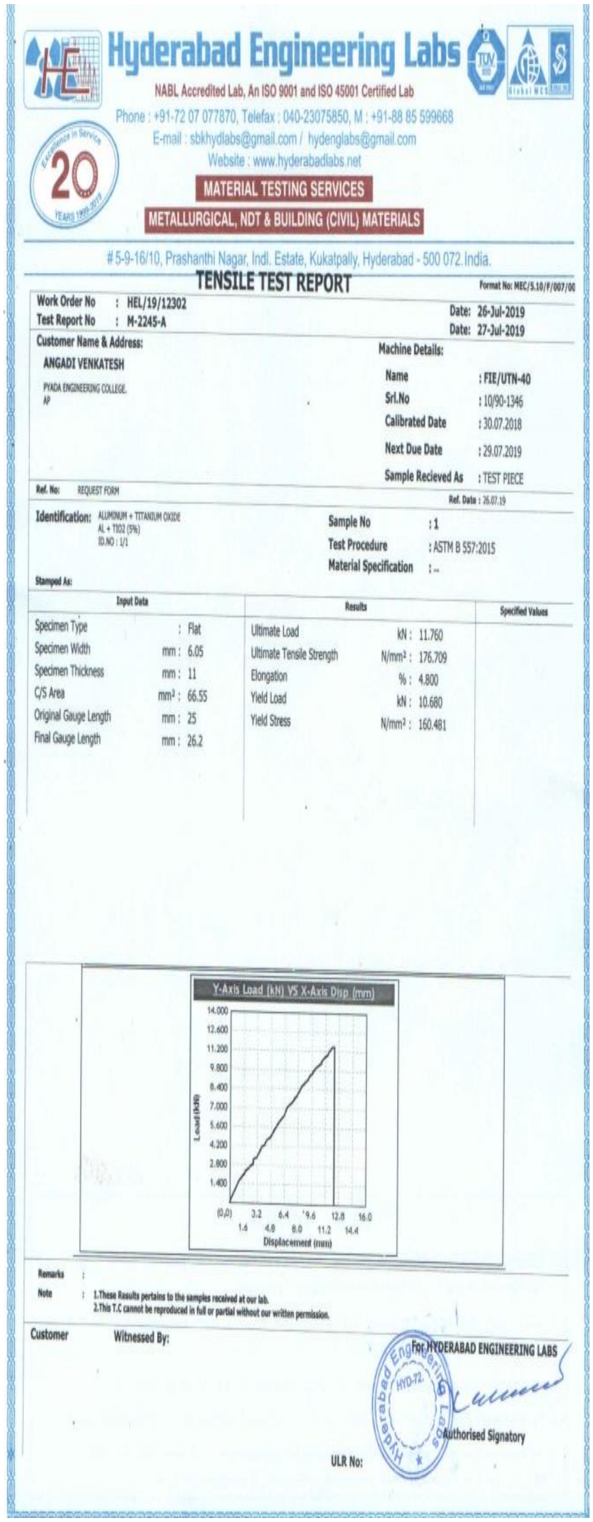

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NABL Accredited Lab, An ISO 9001 and ISO 45001 Certified Lab
Phone : +91-72 07 077870, Telefax : 040-23075850, M : +91-88 85 599668
E-mail : sbkhydlabs@gmail.com / hydenglabs@gmail.com
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TENSILE TEST REPORT

Format No: MEC/5.10/F/007/00

Work Order No : HEL/19/12302 — Date: 26-Jul-2019
Test Report No : M-2245-A — Date: 27-Jul-2019

Customer Name & Address:
ANGADI VENKATESH
PYADA ENGINEERING COLLEGE,
AP

Machine Details:
Name : FIE/UTN-40
Srl.No : 10/90-1346
Calibrated Date : 30.07.2018
Next Due Date : 29.07.2019
Sample Recieved As : TEST PIECE

Ref. No: REQUEST FORM — Ref. Date : 26.07.19

Identification: ALUMINUM + TITANIUM OXIDE
AL + TIO2 (5%)
ID.NO : 1/1

Sample No : 1
Test Procedure : ASTM B 557:2015
Material Specification : --

Stamped As:

Input Data			Results			Specified Values
Specimen Type		Flat	Ultimate Load	kN	11.760	
Specimen Width	mm	6.05	Ultimate Tensile Strength	N/mm²	176.709	
Specimen Thickness	mm	11	Elongation	%	4.800	
C/S Area	mm²	66.55	Yield Load	kN	10.680	
Original Gauge Length	mm	25	Yield Stress	N/mm²	160.481	
Final Gauge Length	mm	26.2				

Remarks :
Note : 1.These Results pertains to the samples received at our lab.
2.This T.C cannot be reproduced in full or partial without our written permission.

Customer — Witnessed By:

For HYDERABAD ENGINEERING LABS
Authorised Signatory

ULR No:

MICROSTRUCTURE TEST REPORTS

From the Microstructure test reports it is found that the microstructure consists of grain structure of austenite and ferrite matrix.

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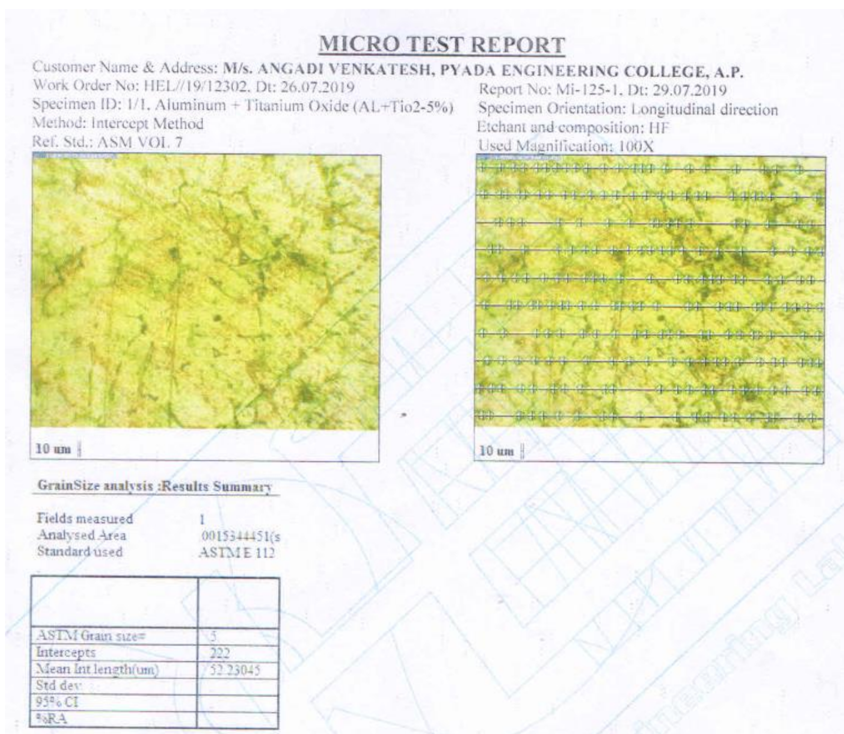

MICRO TEST REPORT

Customer Name & Address: **M/s. ANGADI VENKATESH, PYADA ENGINEERING COLLEGE, A.P.**
Work Order No: HEL//19/12302. Dt: 26.07.2019
Specimen ID: 1/1. Aluminum + Titanium Oxide (AL+Tio2-5%)
Method: Intercept Method
Ref. Std.: ASM VOL. 7
Report No: Mi-125-1. Dt: 29.07.2019
Specimen Orientation: Longitudinal direction
Etchant and composition: HF
Used Magnification: 100X

10 um

10 um

GrainSize analysis :Results Summary

Fields measured 1
Analysed Area 0015344451(s
Standard used ASTM E 112

ASTM Grain size=	5
Intercepts	222
Mean Int length(um)	52.23045
Std dev	
95% CI	
%RA	

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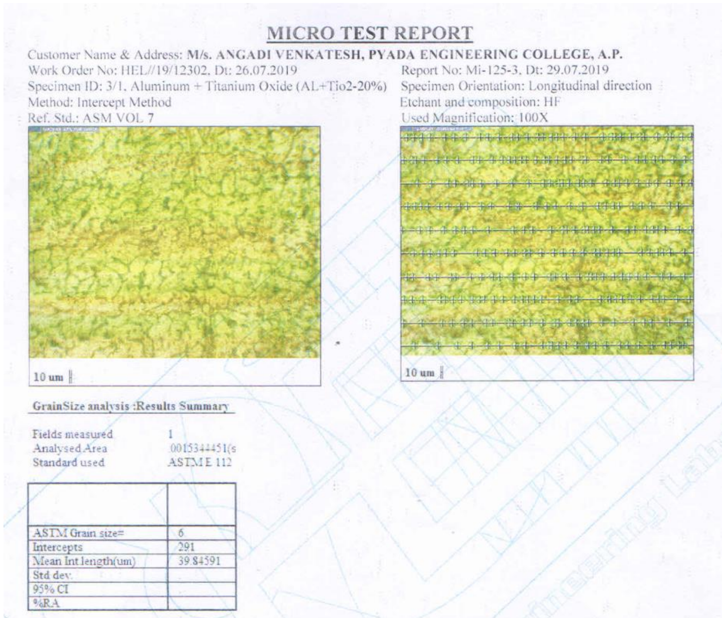

MICRO TEST REPORT

Customer Name & Address: **M/s. ANGADI VENKATESH, PYADA ENGINEERING COLLEGE, A.P.**
Work Order No: HEL//19/12302, Dt: 26.07.2019
Report No: Mi-125-3, Dt: 29.07.2019
Specimen ID: 3/1, Aluminum + Titanium Oxide (AL+Tio2-20%)
Specimen Orientation: Longitudinal direction
Method: Intercept Method
Etchant and composition: HF
Ref. Std.: ASM VOL 7
Used Magnification: 100X

10 um

10 um

GrainSize analysis :Results Summary

Fields measured 1
Analysed Area .0015344451(s
Standard used ASTM E 112

ASTM Grain size=	6
Intercepts	291
Mean Int length(um)	39.84591
Std dev.	
95% CI	
%RA	

CONCLUSIONS

Experiments are conducted on the work pieces by varying parameters. The process parameters varied and their respective values are Pulse Time on - 105µsec, 115 µsec, 125µsec & Pulse Time off – 32 µsec, 42 µsec, 52 µsec, Discharge Current – 10Amp, 11Amp, 12Amp. Other parameters are kept constant such as Wire Feed – 2mm/s, Wire dia - 0.25mm; Coolant is Distilled water, Wire Tension – 7Kgf. The optimization is done by using Taguchi technique considering L9 orthogonal array. Optimization is done in Minitab software. Tensile and Microstructure tests are performed on the pieces.

From the Optimization techniques, the following results can be obtained:

From Taguchi Method, for minimum Surface Roughness, the optimum Pulse Time on is 125µsec, Pulse Time off is 42µsec, Discharge Current is 10Amp and the best suited work piece is al + tio2 of 5%. For maximum MRR, the optimum Pulse Time on is 125µsec, Pulse Time off is 42µsec, Discharge Current is 12Amp and best suited work piece is al + tio2 of 10%.

From the Microstructure test reports it is found that the microstructure consists of grain structure higher and better for the 20% titanium composition mixed with aluminum.

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